REMARKS:

1) The specification has been amended to add priority claim information and to correct a few minor editorial matters. These amendments do not introduce any new matter. Entry of the amendments is respectfully requested.

2) The claims have been amended as follows. The subject matter of prior claim 24 has been incorporated into claim 1. Claims 2 and 12 to 24 have been canceled. The remaining claims have been amended editorially for improved consistency and streamlining of terminology, because the original claims where essentially a direct translation of corresponding foreign language claims. These editorial amendments are not submitted for reasons of patentability, but rather reasons of claim style. New claims 27 to 32 have been added to cover inventive features with a somewhat different claim style and terminology in comparison to the original translated claims. The new claims are supported by the subject matter of the original claims or specification as shown in the following table, and do not introduce any new matter. Entry and consideration of the claim amendments and the new claims are respectfully requested.

new claims	27	28	29	30	31	32
original support	cl. 1 + 6 + 24 + 25 + 26	cl. 8; Figs. 1A,1B,1C; p. 8 ln. 1-8; p. 9 ln. 1-7; p. 15 ln. 19-28	p. 16 ln. 5	cl. 9	cl. 10	cl. 11

3) Referring to the fourth paragraph on page 2 of the Office Action, the priority claim information has been added to the specification at page 1, as required by the Examiner.

4) Referring to the fifth paragraph on page 2 of the Office Action, the non-elected claims 2 and 12 to 23 have been canceled without prejudice to the filing of a divisional application. After the present amendment and addition of new claims, all present claims 1, 6 to 11 and 25 to 32 read on the elected species of the invention.

5) Referring to page 3 of the Office Action, the rejection of claims 1, 25 and 26 as anticipated by JP 04-002120 (JP '120) has been obviated by the present amendment. Amended independent claim 1 incorporates the subject matter of prior claim 24, which was not subject to this rejection. New independent claim 27 incorporates subject matter from prior claims 6 and 24, which where not subject to this rejection. Also, significant differences between the reference and the prior art will be discussed below. Therefore, this rejection cannot apply against any of the present claims. Please withdraw the rejection.

6) Referring to page 4 of the Office Action, the rejection of claims 1, 8, 25 and 26 as anticipated by US Patent 5,628,871 (Shinagawa) has been obviated by the present amendment. Amended independent claim 1 incorporates the subject matter of prior claim 24, which was not subject to this rejection. New independent claim 27 incorporates subject matter from prior claims 6 and 24, which

where not subject to this rejection. Also, significant differences between the reference and the prior art will be discussed below. Therefore, this rejection cannot apply against any of the present claims. Please withdraw the rejection.

7) Referring to page 5 of the Office Action, the rejection of claims 6, 7 and 9 as obvious over JP 04-002120 (JP '120) has been obviated by the present amendment, as discussed above.

More particularly, JP '120 does not disclose and would not have suggested the features of present amended independent claim 1, and much less the features of claims 6, 7 and 9 depending from claim 1.

Amended independent claim 1 is directed to a method of fabricating a semiconductor device that involves providing a mask layer on a region of a surface of an **SiC** semiconductor substrate, wherein the mask layer includes a polyimide resin film, and then implanting dopant ions.

JP '120 does not disclose such a method of ion implantation into an SiC substrate.

The Examiner asserts that the Applicants' Admitted Prior Art (AAPA) (page 1 of the specification) discloses the use of SiC as a substrate (see the rejection of claim 24 on page 6 of the Office Action). However, note that the specification discusses that it is expected that SiC semiconductor material can be used as a substrate for semiconductor devices (page 1 line 16, page 2 line 5). While an SiC semiconductor device is expected to achieve excellent device characteristics, in reality, however, there have only been a small number of reports of successful

fabrication and implementation of such an SiC semiconductor device, and in fact, SiC semiconductor devices are not being positively fabricated (page 2 lines 4 to 9). That is because it is very difficult to carry out dopant diffusion or to control microfabrication steps involving dopant ion implantation in a SiC semiconductor substrate (in comparison to an Si substrate, for example). See the discussion in the specification at page 2 lines 4 to 22.

Still further, <u>the prior art would have provided no suggestion that such difficulties arising with **SiC** material could be avoided or overcome by using a polyimide resin film as a mask for carrying out an ion implantation into the **SiC** semiconductor substrate</u>. Namely, while JP '120 discloses the use of polyimide as a mask material for an ion implantation process, there is no suggestion of using such a mask material for ion implantation into SiC. Instead, <u>the general understanding in the prior art would have been that ion implantation cannot be successfully carried out in the SiC substrate material</u>, for example according to the general prior art understandings discussed in the present specification at pages 2 to 4.

Generally, it is difficult to implant ions into the SiC substrate material with adequate control, and with adequate implantation depth, and with adequate activation of the dopant. To overcome such problems, it could be considered to carry out the ion implantation at a high temperature, but that would prevent conventional resist films from being used as a mask layer for carrying out this ion implantation, because such conventional resist films cannot withstand the high processing temperature.

Still further, if a silicon oxide film or a polysilicon film with adequate thickness would be used as a mask layer for high-temperature high-energy ion implantation, the mask layer tends to crack and peel off. For these reasons, it has not been possible to produce acceptable doped SiC semiconductor substrates by means of ion implantation. In this regard, see the specification at page 2 line 16 to page 3 line 1, and also generally see page 4 lines 4 to 24.

Contrary to such prior art understandings, the present invention has shown that a polyimide resin film can be used as a mask material for successfully carrying out an ion implantation of dopant ions into an SiC semiconductor substrate. Namely, using the polyimide resin film as a mask, it is possible to implant the dopant ions at a high temperature with a high implantation energy in order to introduce the dopant ions into the SiC substrate material at a sufficient depth, for example a depth of 1.1 mμ or deeper (see the specification at page 6 line 19 to page 7 line 3, page 9 lines 8 to 21, and the First to Third Examples at pages 15 to 17).

Since SiC as a substrate material has such different behavior or characteristics with regard to ion implantation, in comparison to other semiconductor substrate materials such as Si, a person of ordinary skill in the art would not have expected to successfully apply the teachings of JP '120 to a substrate comprising SiC semiconductor material.

Claims 6 and 7, depending from claim 1, further expressly recite that the substrate is heated to at least 300°C or at least 500°C, respectively, for carrying out the implantation of the

dopant ions. This high temperature implantation process improves the rate of activation of the dopant, and allows the ion implantation at a high energy to achieve a sufficiently deep dopant implantation. However, the high temperature prevents a conventional resist film from being used as a mask layer for the ion implantation, and also causes significant problems if SiO_2 is used as a mask layer, as discussed above.

The Examiner has acknowledged that JP '120 fails to disclose that the substrate is heated to at least 300°C or 500°C for implanting dopant ions into the substrate through a mask layer comprising a polyimide. The Examiner has asserted that this involves merely selecting the optimum temperature as an obvious routine optimization of the process. However, <u>there is no indication that the implantation temperature is a "result effective variable" to be considered according to JP '120</u>. Furthermore, the problems discussed in the present specification (see page 2 line 23 to page 4 line 24) demonstrate that it is not merely an optimization of temperature that is involved. Namely, using such a high temperature would have destroyed conventional resist films as a mask layer, and while an SiO_2 mask layer can withstand such high temperatures, it is prone to cracking if it is applied in a sufficient thickness to block the high energy implantation of the dopant ions. Thus, neither conventional resist films, nor SiO_2 mask layers are suitable for carrying out ion implantation into an SiC substrate at such high temperatures, and there is no indication by JP '120 that such high implantation temperatures can successfully be used in combination with a polyimide resin film in a mask layer.

Claim 9 depends from claim 1 and further recites that the polyimide resin film has a thickness at least twice a depth of implantation of the dopant ions being implanted into the SiC substrate at a region free of the polyimide resin film. The Examiner has acknowledged that JP '120 fails to disclose such a thickness of the polyimide resin film, but has asserted that this involves merely the obvious selection of this parameter as a routine optimization. This assertion is respectfully traversed. The present application has demonstrated that providing the polyimide resin film to have a thickness at least twice the implantation depth ensures that ions are implanted only at the selected unmasked region, and are entirely blocked by the polyimide resin film at the masked region (see Fig. 2 and the specification at page 9 lines 8 to 21). The <u>prior art does not indicate any study or suggestion regarding the presently claimed thickness</u> of the polyimide resin film.

For the above reasons, the Examiner is respectfully requested to withdraw the rejection of claims 6, 7 and 9 as obvious over JP '120.

8) Referring to page 6 of the Office Action, the rejection of claims 10, 11 and 24 as obvious over JP 04-002120 (JP '120) in view of Applicants' Admitted Prior Art (AAPA) is respectfully traversed.

The subject matter of prior claim 24 has been incorporated in amended independent claim 1.

Regarding prior claim 24, the Examiner acknowledged that JP '120 (abstract) does not disclose the substrate being an SiC substrate. The Examiner asserted that AAPA discloses the use

of SiC as a substrate. However, it must be recognized that the AAPA actually discusses problems and hindrances in the development of SiC as a substrate material for semiconductor devices, as discussed above. For example, the AAPA states that it is <u>expected</u> that the SiC material will be suitable for semiconductor devices (page 1 line 16 and page 2 line 5) but further explains that the SiC semiconductor substrate hardly allows dopant diffusion, and also makes it difficult to precisely control fabrication parameters such as the channel density, and does not allow adequate dopant implantation depth unless the implantation is carried out at high energy at high temperature, which gives rise to further problems (see pages 2 to 4 of the present specification). There is <u>no indication in the AAPA or in JP '120 that the use of a polyimide resin film as a mask layer on a SiC substrate will overcome such problems and difficulties in the prior art as pointed out in the present application</u>. In other words, while it might be known that a polyimide resin film can be used as a mask layer on a semiconductor substrate <u>other than</u> SiC, and it might be separately known that an SiC substrate material will hopefully be developed for semiconductor devices, there would have been no suggestion that a combination of these two features could have overcome difficulties in the conventional development of SiC as a semiconductor device substrate material.

Claims 10 and 11 depend from present claim 1 and recite that <u>a thin metal film or a thin SiO_2 film is further interposed between the polyimide resin film and the SiC semiconductor substrate</u>. The Examiner has acknowledged that JP '120 does not

disclose such a feature. The Examiner has asserted that such a feature is suggested by the AAPA. However, the AAPA actually discusses the use of an SiO_2 film **alone** as a **single** or **sole** mask layer, and that such an SiO_2 mask is **not** preferable for use on an SiC substrate (see page 4 lines 4 to 24).

Moreover, present claims 10 and 11 are not directed to the use of an SiO_2 film or a metal film by itself as a single sole mask layer, but rather are directed to a mask layer that includes **both** a polyimide resin film **and** an SiO_2 or metal film between the polyimide resin film and the substrate. In this inventive context, the SiO_2 or metal film serves a very different purpose, namely not as a ion implantation masking material, but rather as a release layer to facilitate the later removal of the polyimide resin film (see page 9 line 22 to page 10 line 2). Namely, the polyimide resin film is very adhesive on the SiC substrate, and is also highly chemically resistant, so that it can be difficult to remove the polyimide resin film applied directly on the SiC substrate. Therefore, the metal film or SiO_2 film is interposed between the polyimide resin film and the SiC substrate, because the interposed film can be more easily released and removed from the substrate.

The prior art would not have suggested anything regarding such a **combination** of a polyimide resin film stacked on a metal or SiO_2 film on the SiC substrate. Even following the Examiner's suggestion, the result would simply have been an SiO_2 layer or a metal layer as a single sole mask layer instead of the polyimide resin film as a mask layer, not in addition to the polyimide resin film. Thus, it would not have been obvious to use the

presently claimed combination, because there would have been no suggestion or motivation to provide the metal film or SiO_2 film between a polyimide resin film and the substrate.

For the above reasons, the Examiner is respectfully requested to withdraw the rejection of claims 10, 11 and 24 as obvious over JP '120 in view of the AAPA.

9) The Office Action sets forth only an anticipation rejection but no obviousness rejection applying the Shinagawa reference. That anticipation rejection has been overcome because present amended independent claim 1 requires an SiC substrate, which is not disclosed by Shinagawa, as discussed above. Furthermore, the disclosure of Shinagawa would not have suggested the present invention. While Shinagawa generally discloses the use of a photosensitive polyimide mask in an ion implantation process, Shinagawa does not suggest the use of such a mask on an SiC semiconductor substrate. The Examiner has asserted that the use of SiC as a substrate material is known from Applicants' Admitted Prior Art (AAPA), but the specification actually discusses that it is <u>expected</u> that SiC will be developed as a substrate material for semiconductor devices (page 1 line 16, page 2 line 5, etc.) and points out the difficulties and hindrances in such development attempts (as discussed above). A person of ordinary skill in the art considering the disclosure of Shinagawa would have found no suggestion or motivation to apply the polyimide mask to a substrate of SiC semiconductor material to carry out ion implantation, because <u>a person of ordinary skill would have expected that ion implantation cannot be successfully carried out</u>

in an SiC substrate for the reasons discussed in the present specification at page 2 line 4 to page 4 line 24. Therefore, Shinagawa also cannot be used to support an obviousness rejection.

10) The new claims are also patentably distinguishable over the prior art. Independent claim 27 recites steps of providing a semiconductor substrate comprising SiC, providing a mask layer including a polyimide resin film, and implanting dopant ions into the substrate while the substrate is at least 300° C. Such features have been discussed above in comparison to the prior art. There would have been no suggestion by the prior art that such a combination of features would have successfully achieved dopant implantation into the semiconductor substrate comprising SiC. The dependent claims 28 to 31 recite additional features that further distinguish the invention over the prior art.

11) Favorable reconsideration and allowance of the application, including all present claims 1, 6 to 11 and 25 to 32, are respectfully requested.

Respectfully submitted,
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